TITLE

WATER PURIFICATION APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates generally to water purification systems and, in particular, to a point of use water purification apparatus utilizing a three-step purification process together with a piping bypass.

Water purification systems and methods are well known. Ensuring a safe and healthy water supply free from particle, chemical and microbiological impurities, such as bacteria and the like, is an ongoing concern in many parts of the world. The prior art has recognized this and provided various biocides and other systems aimed at exterminating and/or removing bacteria. Perhaps the most common means for exterminating and/or removing bacteria from water supplies is with the use of chlorine.

Chlorine is a powerful oxidizing agent and biocide and has been used for many years by municipal water treatment systems to disinfect water for personal and commercial use. Although it is an effective biocide and is economical to use, chlorine has been suspected to adversely affect living organisms when supplied at excessive levels beyond that required to exterminate the bacteria. In addition to initially treating the water, the water treatment system also typically supplies a residual, called the free chlorine residual, to maintain a level of chlorine sufficient to protect the water from bacteria throughout the water distribution system and the network leading to its point of use. In order to ensure an effective level of chlorine at the point of use farthest from the source, the chlorine level at points of use closer to the source will be higher than desirable. The impact of the free residual chlorine is disadvantageous and significant. The free chlorine residual alters the odor and taste of water as well as bleaches any colored organic objects including skin and hair. In addition, chlorine is itself suspected to be a carcinogen as well as a key component in the formation of trihalomethanes, which are also carcinogenic.

Despite the disadvantages and risks noted above, chlorine remains arguably the most economical and effective biocide for drinking water ever used and, therefore, its use as a biocide remains prevalent today. Many prior art systems exist that teach means to remove

chlorine from water. Other prior art systems exist that teach other biocides as substitutes for chlorine. Most of these prior art removal systems or chlorine substitutes are either cost-prohibitive, difficult to apply, difficult to maintain, or a combination of all of the above.

It is desirable to provide an apparatus for removing chlorine from a municipal water supply that is both economical and simple to apply.

It is also desirable to provide an apparatus for removing chlorine that is simple to operate and maintain. It is also desirable to provide an apparatus that may be maintained while still sustaining water flow for the point of use.

It is, therefore, an object of the present invention to provide an apparatus to eliminate taste, odor, and health-related effects associated with the free chlorine residual provided from a municipal water supply. It is another object of the invention to provide an apparatus for removing chlorine from a municipal water supply at a point of use which apparatus is economical and simple to apply, operate, and maintain.

SUMMARY OF THE INVENTION

The present invention concerns a water purification apparatus for connection to a municipal water supply having a quantity of free residual chlorine. The present invention advantageously removes the free residual chlorine from the municipal water supply just before a point of use. The present invention accomplishes this by connecting the water supply into an inlet of a carbon filter. The carbon filter is preferably sized, based on the capacity of the water supply and the point of use, to absorb the free residual chlorine.

An outlet of the carbon filter is connected to an inlet of a particle filter. It is known in the art that carbon filters typically shed some carbon particles during normal use. The present invention recognizes this, and provides the particle filter, which is preferably a particulate filter that can remove these carbon particles as well as any other solid particles found in the municipal water supply. The particle filter is preferably sized to remove an amount of solids based on the properties of the water supply and the requirements of the point of use. For example, manufacturing requirements may be much stricter in terms of total dissolved solids (TDS) than that of a typical municipal water supply.

An outlet of the particle filter is connected to an inlet of an ultraviolet light source for sanitizing, or disinfecting, the water prior to its point of use. It is known in the art that carbon filters can create an environment suitable for microbiological growth because such filters contain a dark and humid environment. The present invention recognizes this, and provides the ultraviolet light source, which advantageously disinfects the water without impacting the taste or the odor of the water. The ultraviolet light source also disinfects the water instantaneously with no residual effects. The outlet of the ultraviolet light source is connected to the point of use of the water, such as a residence or office building.

The apparatus includes a bypass conduit connected in parallel with the purification units (the carbon filter, the particle filter, and the ultraviolet light source). The bypass is connected between the water supply and the point of use. The water purification apparatus further includes associated valves that are provided to isolate the purification units for performing maintenance on the apparatus.

The present invention advantageously contemplates utilizing low-cost, commercially available standard equipment to eliminate chlorine from drinking water and from water used in food, beverage, and related uses. Furthermore, the present invention advantageously provides the bypass conduit to allow easy maintenance of the components of the present invention. The present invention also extends the life or operating hours of the carbon filter, the particle filter and the ultraviolet light source by utilizing the bypass conduit during periods when the purification process is not needed. For example, during closing hours of a business establishment, office, etc. The bypassed chlorinated water can flow until it is necessary to go back to the purified water during demand or peak use periods. This operation also keeps the bypass conduit bacteria free with the chlorinated water flow. The present invention, therefore, is a low-cost yet effective and efficient means for removing chlorine from a municipal water supply. In addition to domestic potable water use, the present invention contemplates uses in many industrial sectors where chlorine can affect the process or final product characteristics including, but not limited to, the paper, textiles, food, and beverage industries.

In addition, the present invention is scalable in that it is not limited to certain values of water flow, the amount of free residual chlorine, or the amount of TDS. Filter and piping sizes are dependent on a number of factors, including water flow and the amount of free chlorine

measured in the water. The components of the present invention (the carbon filter, the particle filter, and the ultraviolet light source) can be custom designed for each specific point of use water distribution system, and it also is within the scope of the present invention to mass produce the components for typical residential applications.

DESCRIPTION OF THE DRAWINGS

The above, as well as other advantages of the present invention, will become readily apparent to those skilled in the art from the following detailed description of a preferred embodiment when considered in the light of the accompanying drawings in which:

Fig. 1 is a schematic block diagram of a water purification apparatus in accordance with the present invention;

Fig. 2 is a schematic block diagram of an alternate embodiment of the apparatus shown in Fig. 1; and

Fig. 3 is a schematic block diagram of a control for the apparatus shown in Fig. 1

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Fig. 1, a water purification apparatus is indicated generally at **10**. The water purification apparatus **10** includes a water supply inlet conduit **12**. The water supply inlet conduit **12** is preferably piping, tubing, or the like that is connected to a chlorinated municipal water supply network (not shown) for receiving water to be used at a point of use for drinking, cooking, bathing, etc. The water supply inlet conduit **12** may be constructed of any suitable conduit material including, but not limited to, steel, copper, or polyvinyl chloride (PVC). The water supply inlet conduit **12** extends to a tee coupling **14**, which branches to a filtration apparatus inlet conduit **16** and a bypass conduit **18**. The apparatus inlet conduit **16**, the bypass conduit **18**, and the tee **14** may be constructed of any suitable conduit material including, but not limited to, steel, copper, or PVC.

The apparatus inlet conduit **16** connects to an inlet of a carbon filter bed **20**. The carbon filter **20** includes carbon beds (not shown) that have a quantity of activated charcoal (not shown) for absorbing free residual chlorine (not shown) contained in the water flowing from the municipal water supply. The carbon filter **20** is preferably a commercially available

carbon filter bed. The carbon filter **20** is preferably sized to remove all or substantially all of the chlorine based upon a maximum flow capacity of the point of use and the amount of chlorine in the water at the supply inlet conduit **12**. Alternatively, the carbon filter **20** is formed of two or more such filters connected in parallel and/or series depending on the amount of free chlorine residual to be removed. Typically, two or more filters would be required only in large commercial or industrial applications.

An outlet of the carbon filter **20** is connected to an inlet of a particle filter **22**. The particle filter **22** is preferably a particulate filter that can remove carbon particles (not shown) shed from the carbon filter **20** as well as any other solid particles (not shown) found in the water received from the municipal water supply. The particle filter **22** is preferably a commercially available particle filter. The particle filter **22** is preferably sized to remove an amount of solids based on the capacity and properties of the water supply and requirements of the point of use. Alternatively, the particle filter **22** is formed of two or more such filters connected in parallel and/or series depending upon the amount of solids to be removed from the water. As stated above, typically, two or more filters would be required only in large commercial or industrial applications.

An outlet of the particle filter **22** is connected to an inlet of an ultraviolet light source **24** for sanitizing the water prior to its point of use. The ultraviolet light source **24** preferably includes a housing (not shown) with at least one ultraviolet light bulb (not shown) disposed therein for exposing the water to the ultraviolet light rays to kill bacteria. The ultraviolet light source **24** advantageously does not impact the taste or the odor of the water. The ultraviolet light source **24** also sanitizes the water instantaneously with no residual effects. The ultraviolet light source **24** is preferably a commercially available ultraviolet light source. Alternatively, the ultraviolet light source **24** is formed of two or more such light sources connected in parallel and/or series depending upon the amount of bacteria present. As stated above, typically, two or more sources would be required only in large commercial or industrial applications. An outlet of the ultraviolet light source **24** connects to a tee coupling **26**, a branch of which is a point of use conduit **28**, which is further connected to a point of use (not shown), such as a domestic water faucet, a water inlet for a dwelling, or a water inlet for industrial processing operations.

The point of use conduit **28** and the tee **26** may be constructed of any suitable conduit material including, but not limited to, steel, copper, or PVC.

The bypass conduit **18** extends from the first tee **14** to the second tee **26**. The water purification apparatus **10** also includes at least three valves, including a bypass valve **30**, an inlet valve **32**, and an outlet valve **34**. The bypass valve **30** is located in the bypass conduit **18** between the tee **14** and the tee **26**. The inlet valve **32** is located in the apparatus inlet conduit **16** between the tee **14** and the carbon filter **20**. The outlet valve **34** is located in the apparatus inlet conduit **16** between the ultraviolet light source **24** and the tee **26**.

During normal operation of the water purification apparatus **10**, the bypass valve **30** is closed and the inlet valve **32** and the outlet valve **34** are open. Water flows from the municipal source into the water inlet conduit **12**, through the carbon filter **20**, through the particle filter **22**, through the ultraviolet light source **24**, through the point of use conduit **28**, and on to the point of use. The water arrives at the point of use free of chlorine, free of solids and free of bacteria.

The carbon filter **20**, the particle filter **22** and ultraviolet light source **24** all include parts that will need to be replaced during normal use of the water purification apparatus **10**. The frequency of parts replacement in the carbon filter **20** and the particle filter **22** depends in large part on the quality of the municipal water supply and the operating time in use. During maintenance of the water purification apparatus **10**, the bypass valve **30** is open, and the inlet valve **32** and the outlet valve **34** are closed. In this valve configuration, maintenance personnel are able to perform maintenance including replacing the activated charcoal carbon filter **20**, cleaning or replacing the filter cartridge in the particle filter **22**, replacing the ultraviolet light bulbs in the ultraviolet light source **24**, and/or performing any other maintenance on the water purification apparatus **10**, between the inlet valve **32** and the outlet valve **34**, as may be required. All of the maintenance may be performed without completely interrupting the water supply to the point of use and without requiring the drainage of the entire water system. The bypass conduit **18** allows for sanitizing the point of use water distribution network via the existing free chlorine in the water. The bypass conduit **18** may be utilized advantageously during off-peak hours or during times when taste, odor, or other chlorine characteristics are not an issue of significance. Utilizing the bypass conduit **18** during these times can increase the

interval required to perform maintenance on the carbon filter **20**, the particle filter **22** and ultraviolet light source **24**, decreasing the likelihood that the bypass conduit **18** will need to be used during peak hours.

To assist in the maintenance of the water purification apparatus **10**, the water supply inlet conduit **12** is connected to an optional water meter **36** that measures the amount of water flowing through the water purification apparatus **10**. Information obtained from the water meter **36** can be used to size the system components and adjust them if necessary. The water meter **36** could be the meter typically used by the municipality to measure customer water use.

Preventative maintenance of mechanical systems is typically performed based on an amount of time the system has been in service or an amount of work cycles the system has experienced. Preventative maintenance is also typically based on observed conditions. Preventative maintenance of the water purification apparatus **10** may be performed based on the amount of water that has flowed through the water purification apparatus **10**, as measured by the water meter **36**. Preventative maintenance may also be performed on the water purification apparatus **10** based on actual pressure differential readings, as measured by at least three optional pressure gages **38**, **40**, and **42**. The pressure gage **38** is located on the bypass conduit **18** between the tee **14** and the tee **26**. The pressure gage **40** is located in the apparatus inlet conduit **16** between the tee **14** and the carbon bed filter **20**. The pressure gage **42** is located in the apparatus inlet conduit **16** between the ultraviolet light source **24** and the tee **26**. A high pressure differential between the pressure gage **40** and the pressure gage **42** will indicate that there likely is a flow restriction in either the carbon filter **20**, the particle filter **22** and/or the ultraviolet light source **24**, and that maintenance, such as that outlined above, is required on one of those purification devices.

Also, the water meter **36** and the pressure gages **38**, **40**, and **42** provide signals (not shown) to a control means (not shown), which can monitor the water purification apparatus **10**, and alert an operator of the water purification apparatus **10** when maintenance needs to be performed.

As discussed above, each of the purification units, i. e. the carbon filter **20**, the particle filter **22** and the UV light source **24**, can be configured as two or more units in parallel and/or series. As shown in Fig. 2, a first unit **50** can be connected in parallel with a similar second

unit **52**. The parallel connection can be used where one of the units does not have sufficient capacity for the maximum water flow in the inlet conduit **16**. Also, the second unit **52** can be added after installation of the water purification apparatus **10** should the maximum water flow increase and exceed the capacity of the first unit **50**. A third unit **54** can be connected in series with the first unit **50** when additional purification is required beyond the capacity of the first unit **50** but the maximum flow capacity has not been exceeded. In this case, the second unit **52** may not be required. Additional parallel or series connected units can be added. Clearly, the water purification apparatus **10** can be configured with any desired number of purification units (**20**, **22**, **24**) connected in series and/or parallel.

There is shown in Fig. 3 a control **60** for the water purification apparatus **10**. The pressure gages **38**, **40** and **42** are each connected to an input of the control **60** and generate input signals representing the water pressure at the points of connection to the conduits shown in the Fig. 1. The water meter **36** is connected to another input of the control **60**. Outputs of the control **60** are connected to actuators of the valves **30**, **32** and **34**. The control **60** can be any suitable device such as a programmed logic controller (PLC) or a programmed personal computer that responds to inputs such as the sensed pressures (from the gages **38**, **40**, **42**), the water flow rate (from the water meter **36**), the time of day (from an internal clock) or operator commands to open and shut the valves.

In accordance with the provisions of the patent statutes, the present invention has been described in what is considered to represent its preferred embodiment. However, it should be noted that the invention can be practiced otherwise than as specifically illustrated and described without departing from its spirit or scope.